Lambda-proton correlations in relativistic heavy ion collisions [1]

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Two-particle correlations have proven to be a powerful tool for determining source sizes and lifetimes in heavy ion collisions. Here we report a first investigation to use lambda-proton (Λp) correlations to study baryon sources in these collisions.

An Urbana-type potential [2] is used to generate the Λp relative wave functions. The wave functions are then used to calculate correlation functions. The correlation functions are illustrated in Fig. 1 for Gaussian sources of radius $R_g = 4, 6$ and 10 fm. For illustration, we have used the same source size for both lambdas and protons, and assumed thermal momentum distributions. Also shown are two-proton (pp) correlations for the same source sizes. Clearly, Λp correlations are more sensitive than pp correlations for determining larger source sizes. Despite the fact that the pp scattering length is considerably longer, Coulomb effects obscure the sensitivity of pp correlation for sources larger than approximately 6 fm.

Unlike particle correlations can be exploited to study whether the particles are emitted simultaneously [3]. If the lambdas are emitted before the protons in such a way that the probability cloud describing the protons lags that for the lambdas of the same velocity, the correlation function then depends on the sign of the relative momentum in the direction defined by that of the displacement of the lambda and proton clouds. Detailed calculations show that a measurement of a few percent at $k \sim 30$ MeV/c would be able to identify a difference in the emission time on the order of 2 fm/c [1].

In summary, Λp correlations may provide a useful characterization of the space-time structure of relativistic heavy ion collisions. The lack of a relative Coulomb interaction allows the strong interaction to produce a large peak in the correlation function even for large sources, to which pp correlation loses its sensitivity. Furthermore, by binning according to the sign of the projected relative momentum, one might address the question of whether lambdas and protons are emitted simultaneously.

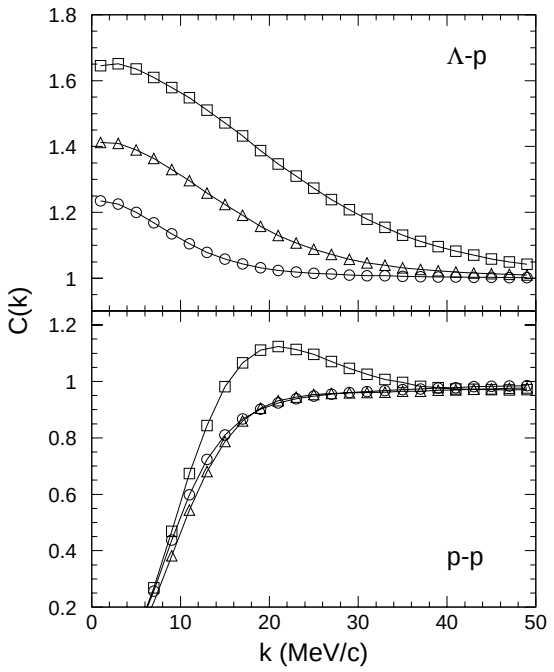

Figure 1: Λp (upper panel) and pp (lower panel) correlation functions for R_g=4 fm (squares), 6 fm (triangles) and 10 fm (circles). $k = |\mathbf{p}_\Lambda - \mathbf{p}_p|/2$ as measured in the pair center-of-mass frame.

References

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